



Arizona Department of Transportation

ROADWAY ENGINEERING GROUP

MEMORANDUM

To: Roadway Design Personnel
ADOT and Consultants

Date: November 15, 2002
ORIGINAL MEMO DATE

From: John L. Louis
Assistant State Engineer
Roadway Engineering Group

Subject:
**Design Exception and Design Variance
Process Guide**

The subject Process Guide was developed to provide guidance and to set forth requirements and procedures for obtaining design exception approvals during the predesign and design stages of project development. Changes have been implemented in the definition of what was previously considered a design exception: there are now “design exceptions” required for those elements considered to be controlling design criteria and “design variances” for other essential design elements.

Please distribute the attached Process Guide to design engineers and project managers in your respective Groups and encourage them to become familiar with the new guidelines. The new guidelines shall be implemented in the Predesign Stage at the earliest timeframe determined practical by the Predesign Project Manager. During the Design Stage of an ongoing project, the new guidelines shall be implemented for all new design exception or design variance requests.

Please contact the Roadway Group for any questions or discussion on the Process Guide.

C:
Roadway Engineering Group
Statewide Project Management
Contracts and Specifications Section
Valley Freeway Group
Bridge Group
FHWA
Regional Traffic Engineers (4)

District Engineers (10)

Traffic Engineering Group
Engineering Consultant Services

**DESIGN EXCEPTION AND DESIGN VARIANCE
PROCESS GUIDE**

**ARIZONA DEPARTMENT OF TRANSPORTATION
ROADWAY ENGINEERING GROUP**

NOVEMBER, 2002

(Page 3 Revised 10/04/06)
(Appendix Updated 1/16/07)

DESIGN EXCEPTIONS AND DESIGN VARIANCES

PROCESS GUIDE

SCOPE: In the geometric design of highway projects there are certain design values that are prescribed in the ADOT Roadway Engineering Group design manual *Roadway Design Guidelines* (RDG) and the AASHTO *A Policy for Geometric Design of Highways and Streets* (Green Book) that have been determined to be paramount to a properly designed highway. When it is determined that it is not practical for these design values to be met, documented justification must be submitted and approval must be obtained for inclusion in the design plans. The purpose of this guide is to specify a) the design guidelines applicable to various types of projects b) exception justification requirements and c) procedures required to obtain needed approvals.

DESIGN EXCEPTIONS: Design Exceptions are required when design values selected for design do not meet the design requirements of the basic “Controlling Design Criteria”. The AASHTO Green Book “Controlling Design Criteria” are identified in the document Procedural Guide for Review of the AASHTO Controlling Design Criteria on Existing ADOT Highways (Procedural Guide) and are listed herein on page 6. ADOT corresponding values for the “Controlling Design Criteria” are found in the RDG. The ADOT RDG values for the “Controlling Design Criteria” are equal to or more conservative than the design values specified in AASHTO.

Design Exceptions are required with project types as follows:

1. For new construction and major reconstruction, design elements shall conform to the requirements of the ADOT RDG. A list of the RDG Design Exception elements is listed in the Appendix.
2. For existing roadway design elements to remain, Design Exceptions are required for design values not meeting the AASHTO Controlling Design Criteria outlined in the Procedural Guide.

DESIGN VARIANCES: Design Variances are required for utilization of design values for new construction that do not meet the design values prescribed in the RDG. These design values are separate from the basic controlling design criteria that require RDG Design Exceptions. The design values requiring Design Variances are listed in the Appendix. They are identified in the RDG and in supplemental design memorandums where the word “shall” is specified in the text.

PROJECT TYPES: The following Design Exception/Design Variance Table provides guidance for determination of the need for Design Exceptions and/or Design Variances based on the scope of construction project:

(Project Type 3 of This Table Revised 10/04/06)

Design Exception/ Design Variance Table

<u>Project Type</u>	<u>Design Exceptions Required</u>		<u>Design Variance Required</u>
	<u>AASHTO</u>	<u>ADOT RDG</u>	<u>ADOT RDG + MEMOS</u>
1. New Construction (Major)			
a. New route or bypass		x	x
b. New divided highway			
1) New parallel roadway		x	x
2) Existing roadway to remain	x		
2. Reconstruct Existing Roadway			
a. Total reconstruct		x	x
b. Partial reconstruct			
1) Existing roadway to remain	x		
2) Reconstruct roadway portion		x	x
c. Realignment		x	x
3. Widen Existing Roadway (1)	x (5)	x (6)	x
4. Intersections			
a. Reconstruct-New Profile		x	x
b. Widen Pavement Only		x (2)	
5. Pavement Preservation			
a. Existing Conditions	x		
b. Roadway Reconstruction		x (3)	x
6. Striping			
a. Restripe as-built		n/a	
b. Restripe with new lane width		x (4)	
7. Spot Improvements			
a. No profile change		n/a	
b. New profile		x	x

(1) For passing lane/climbing lane additions, use “ A Policy on the Design of Passing Lanes and Climbing Lanes” December, 1997.

(2) Exceptions needed for lane width, shoulder width, and intersection sight distance.

(3) Intersections per item 4.

(4) Exceptions required for lane width and shoulder width.

(5) For existing roadway to remain as determined by Roadway Predesign.

(6) For the new widened roadway portion.

PROCESS:

Predesign Stage: Roadway projects are routinely scoped for programming with a Scoping Letter, Project Assessment (PA), Design Concept Report (DCR) or Location Design Concept Report (L/DCR). Roadway Predesign Guidelines for preparation of these documents describe the Design Exception process for each type of scoping document.

A separate justification letter requesting approval of the Design Exception or Design Variance is prepared by the design engineer and submitted to the Predesign Program Manager. The Pre-design Program Manager sends all Design Exception and Design Variance requests to the Assistant State Engineer, Roadway Engineering Group for review and approval. The Assistant State Engineer, Roadway Group may require the concurrence of the Assistant State Engineer, Bridge Group for bridge related design exceptions or the Assistant State Engineer, Traffic Group for traffic related design exceptions. Following review and concurrence by the Assistant State Engineer, Roadway Engineering Group the Predesign Program Manager submits Design Exceptions to FHWA for approval as required in accordance with the guidelines set forth in the following section.

Design Exception and Design Variance requests for scoping documents prepared outside of Roadway Pre-design are to be submitted by the design engineer through the Project Manager to the Predesign Program Manager for processing.

FHWA Review and Approval: Design Exceptions

Design Exception requests are sent to the FHWA for review and approval on all projects on the Interstate System. In addition, there may be a few projects not on the Interstate System which are identified by FHWA for full FHWA oversight (Category “N” or Category “X” projects). Design Exception requests for these projects shall also be sent to FHWA for review and approval. Categories of FHWA project oversight are delineated in FHWA Development Guidelines Number DG-33 currently dated December 5, 2001.

Disposition of Final Documents – Predesign Stage:

All Design Exception and Design Variance requests and approvals during the predesign stage are filed with the Scoping Documents for permanent record in Roadway Predesign.

For projects having partial or limited FHWA oversight and review (Category “A” and Category “B”) copies of approvals made by the Assistant State Engineer, Roadway Group, accompanied by the supporting documentation, shall be sent to the FHWA for their information and records. Copies of AASHTO Design Exception approvals are sent to ADOT Contracts and Specifications Section.

Design Stage:

The need for Design Exceptions and Design Variances during the roadway design stage of a project should be minimized with a thorough analysis during the scoping or pre-design stage. It is however, not uncommon in the refinement of design elements during the design stage and after obtaining more precise design data that the need for design exceptions or variances becomes evident. It is important that the design engineer address these changes from the scoping document early and in an expedient manner. By addressing the potential exceptions or variances in the early stage of design, impacts on schedule and project cost can be minimized. All of the controlling design elements requiring Design Exceptions should be refined and identified by completion of the Stage II plans development.

Stage III design, prior to submittal of plans for review, is the final time that a Design Exception or Design Variance may be submitted for consideration. Identification of the need for Design Exceptions and Design Variances after Stage III is an indication that the designer has not thoroughly reviewed the design for compliance with the applicable standards. Only rarely and with strong justification will requests for Design Exceptions or Design Variances after the Stage III design be considered. Design Exceptions and Design Variances will not be granted based upon a lack of adequate time to make changes to meet the project schedule.

Design Exception and Design Variance requests with appropriate justification will be sent from the design engineer to the Assistant State Engineer, Roadway Engineering Group through the Project Manager. Following review and concurrence by the Assistant State Engineer, Design Exception requests are to be submitted by the Project Manager to the FHWA for review and approval in accordance with the FHWA project designation criteria outlined in the Predesign Stage (Categories: Interstate, “N” and “X”).

Disposition of Final Documents - Design Stage:

The design engineer shall keep all Design Exception and Design Variance requests and approvals in the design project file and send copies to the Assistant State Engineer, Roadway Engineering Group for permanent file. The Assistant State Engineer will keep on permanent file copies of all self-approved Design Exceptions and Design Variances and all FHWA approved Design Exceptions during the design stage. Copies of Design Exceptions approved by the Assistant State Engineer on FHWA Categories “A” and “B” are to be sent by the Project Manager to the FHWA for informational purposes. Copies of AASHTO Design Exception approvals are sent by the Design Engineer to Contracts and Specifications Section.

EVALUATION AND JUSTIFICATION FOR DESIGN EXCEPTIONS and DESIGN VARIANCES:

Requests for Design Exceptions and Design Variances must be accompanied by appropriate justification. Approval of a Design Exception or Design Variance requires **compelling** reasons to justify why the established standard cannot or should not be used.

Consideration must be given for the effects of the variance from the design standard on the **safety and operation** of the facility and the **compatibility with adjacent sections of highway**. Consideration must also be given to the functional classification of the highway, the type of project (e.g. new or reconstruct, 3R), and the amount and character of traffic. **Accident history** may be a factor when evaluating an existing roadway. The cost of obtaining current applicable standards should be weighed with any resultant impacts upon **scenic, historic, and other environmental** features. **Future planned improvements** to the roadway or corridor must be considered.

Issues to be considered in any analysis should **include a) what is the degree to which the standard is being reduced? b) what impacts, if any, will the exception have on other standards?, c) does a reduction in the standard significantly impact the safety in the specific area or the overall project? and d) are there any other additional features (such as signing, delineation, rumble strips) that would mitigate the impacts of the deviation from standard?**

ELEMENTS REQUIRING DESIGN EXCEPTIONS:

A. For Existing Highway Elements to Remain In-Place: Pavement Preservation and for considering reconstruction less than complete Reconstruction. Requires an AASHTO Controlling Design Criteria Report utilizing the Procedural Guide for Review of the AASHTO Controlling Design Criteria on ADOT Roadways. Design elements that are required to be addressed are:

- * **Lane Width**
- * **Shoulder Width**
- * **Vertical Alignment/Stopping Sight Distance**
- * **Horizontal Alignment, Superelevation, and Stopping Sight Distance**
- * **Design Speed**
- * **Maximum Grade**
- * **Cross Slope**
- * **Vertical Clearance**
- * **Bridge Width**
- * **Bridge Structural Capacity**
- * **Bridge Barrier**
- * **Horizontal Clearance to Obstructions** (not clear zone)- AASHTO Green Book.

Note: For Interstate Highways see “A Policy on Design Standards- Interstate System” pamphlet for design values requiring exceptions.

B. For New Construction and Reconstruction: See Design Exception/Design Variance Table

The current edition of the Roadway Design Guidelines (RDG) with any updates, revisions and design memoranda is the basis for Design Exceptions. The AASHTO design criteria **will not be used** as the basis for Design Exceptions unless specifically stated in the RDG.

Section 3.1 of the RDG states “To promote uniformity throughout the state, the use of design values lower than the mandatory standards presented in this manual shall require the written approval of the Roadway Group Manager or authorized designee.” The mandatory standards are those presented using the word “shall”.

See the Appendix for a listing of design elements requiring Design Exceptions.

ELEMENTS REQUIRING DESIGN VARIANCES:

A. For New Construction and Reconstruction: See Design Exception/Design Variance Table

The current edition of the Roadway Design Guidelines (RDG) with current updates, revisions and design memoranda is the basis for Design Variances. Design Variances are needed for all other design values proposed lower than the mandatory standards as stated in the RDG Section 3.1 . These are in addition to and are separate from the RDG Design Exception elements.

See the Appendix for a listing of design elements requiring Design Variances.

Reference List:

1. ADOT Roadway Design Guidelines (RDG), 1996 and current updates.
2. A Policy On Geometric Design of Highways and Streets – AASHTO Green Book
3. Procedural Guide for the Review of the AASHTO Controlling Design Criteria
4. FHWA Development Guideline Number DG-33, December 5, 2001
5. ADOT/FHWA Operating Partnership- Attachment 3 (Action Table)
6. Roadway Predesign Guidelines for Preparation of Scoping Documents:
<http://www.azdot.gov/Highways/RdwyEng/RoadwayPredesign/PDF/Guides.pdf>
 - a. Project Assessment/Scoping Letter/ DCR Guide
 - b. Report Development Guide for Consultants

APPENDIX

This List Updated 1/16/07

DESIGN EXCEPTION/ DESIGN VARIANCE PROCESS GUIDE

This appendix is intended to summarize the key design elements at the time of issue. The items will change with the issuance of new and revised design criteria. The designer may stay abreast of the current design updates by visiting the roadway design website at:

http://www.azdot.gov/highways/RdwyEng/RoadwayDesign/design_memos/Index.asp

The following list summarizes the RDG design elements requiring Design Exceptions and Design Variances:

*Items identified with ** require Design Exceptions. All others require Design Variances. Items identified as **ABSOLUTE** will not be considered for an Exception or a Variance.*

CHAPTER 100 – Design and Criteria

**** Design Speed-** Section 101.3

- Change of Traffic Design Data after Final Scoping- Section 102.2

CHAPTER 200 – Elements of Design

**** Stopping Sight Distance-** Section 201.2

**** Superelevation-** Section 202.1

- Superelevation Transition Length- Section 202.3
- Ramp and Lane Taper Cross Slope- Section 202.3
- Horizontal Alignment Control Coincident with Axis of Superelevation Rotation – Section 203.1

**** Horizontal Sight Distance –** Figure 203.2

- Use of Spiral Curves- Section 203.3
- Profile gradeline coincides with axis of rotation for superelevation- Section 204.2

**** Vertical Alignment Stopping Sight Distance-** Section 204.2

- Minimum Highway Grade over 4000 ft - Section 204.3

**** Maximum Grades-** Section 204.3

- Maximum Grade Break Without Vertical Curve- Section 204.4
- Separate Grade Lines for Divided Highways- Section 204.6

**** Vertical Clearance to Structures-** Section 206.4

- Falsework clearance – Section 206.5

CHAPTER 300 - Cross Section Elements**** Cross Slope-** Section 301.2**** Lane Width and Pavement Width-** Section 301.3**** Minimum shoulder width-** Section 302.4

- Horizontal clearance to obstructions behind curb or curb and gutter- Section 303.2
- Shoulder wedge steeper than 6:1 – Section 303.3
- Minimum Median Width Without Barrier for Rural Highways- Section 304.1
- Median Barrier Warrants- Section 304.4
- Median Curb Types for Urban Highways – Section 304.5
- Guard Rail at Embankment Curbs- Section 305.7
- Rural Cross Section- Section RA to address ultimate design- Section 306.2
- Fringe Urban Section- median width and address ultimate design- Section 306.3
- Sidewalk Ramps conform to ADA – Section 310
- Right of Way Fence- Section 313
- Detour Horizontal Alignment- Section 316.4
- Detour Stopping Sight Distance- Section 316.6
- Detour Sidewalks have Temporary Concrete Barrier- Section 316.8

CHAPTER 400 – At-Grade Intersections

- Use RODEL software model for design of modern roundabouts – Section 403.2
- Skewed intersections exceeding 20 degrees – Section 403.4
- Access Openings on Freeways- Section 405.1 **ABSOLUTE**
- Crossovers- Section 405.1
- Private Road Connections- Section 405.2

**** Intersection Stopping Sight Distance-** Section 408.3

**** Intersection Sight Distance-** Section 408.4

- Intersection Grades- Section 408.8
- Free Right Turns- Section 408.11

CHAPTER 500 - Traffic Interchanges

- Crossroad Grade at Ramp Termini- Section 503.5
- Paved Gore Crossover Rates- Section 504.1
- Loop Ramp Minimum Radius – Section 504.2
- Ramp Taper and Ramp Gore Crossover Rates- Section 504.3
- Ramp Width- Section 504.5
- Parallel exit ramps in urban areas – Section 504.7
- No curbed gores – Section 504.7
- Parallel entrance ramps in urban areas – Section 504.7
- No curbed gores – Section 504.8
- Maximum ramp/crossroad intersection angle – Section 504.1
- Access control limits – Section 506

CHAPTER 600- Highway Drainage

- Federal and State Statutes- Section 602.1
- Design Frequency Changes - Section 603.1
- Bridges and Culverts at Flood Channels or Detention Basins – Section 602.2B
- Pavement Drainage Frequencies- Section 603.2D
- Pavement Drainage Allowable Spread – Section 603.2D
- Pavement Drainage – Sump – Section 603.2D
- Ditches, Channel and Detention Basin Frequency- Section 603.2E
- Capture ratio for Inlets – Section 606.2A
- Bicycle and Pedestrian Safe Grates- Section 606.2B **ABSOLUTE**
- No Curb Opening Inlets for Pump Station Collection - Section 606.2B
- Pipe Material and Pipe Size – Section 607.1
- Use of Pipe Selection Guidelines and Procedures- Section 607.5
- Channel Side Slopes – Section 608.1A
- Channel Velocity and Flow Depth – Section 608.2
- Freeboard for Open Channel - Section 608.4
- Channel Height for Outside Wall in Bend – Section 608.5
- Channel Linings – Section 608.6
- Channel Inflows – Section 608.9
- Maintenance Width for Channels– Section 608.11
- Detention Basin Outflow and Standing Water Retention Period - Section 609.1
- Detention Basin Maximum Depth and Water Level – Section 609.2
- Detention Basins - No Dams- Section 609.2
- Detention Basins – Use of Dry Wells- Section 609.2

- Detention Basin Emergency Spillways – Section 609.4
- Bridge Backwater Requirements – Section 610.1
- Bridge Hydraulic Calculations – USACE HEC-RAS program – Section 610.2E
- Skew and Scour at Bridge Foundations- Section 610.2F
- Culverts Having Earth Inverts – Section 611.1
- Box Culvert Minimum Size- Section 611.3A
- Hydraulic Design of Closed Invert Culverts – Section 611.3B
- Culvert Backwater – Section 611.3C
- Culvert Concrete Headwall Requirement and Attachment to Culvert – Section 611.3G
- Culvert Combination Stock/Vehicle/Equestrian Pass Limitation – Section 611.3K
- Structural Plate Pipe – Paved Invert and Headwall Requirement – Section 611.3K
- Erosion and Sediment Control Design Requirements - Section 612.1
- Erosion Control Linings – Section 612.2A
- Grade Control Structures – Section 612.2B
- Bank Protection – Section 613.1 & Section 613.2
- Pump Station Design – Section 614.1
- Pump Station Storage Reservoirs – Section 614.2
- Pump Station Site Layout and Access – Section 614.5
- **CHAPTER 700 – EARTHWORK DESIGN**
- Ground Compaction Application to Embankment Areas – Section 701.4